Occupational Work Evaluation of Patients With Cardiac Disease: A Guide for Physicians

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The capacity of cardiac patients to work in their occupations reflects a complex interaction of medical and nonmedical factors. Medical considerations include prognosis and the ability of patients to tolerate the physical, environmental and psychological aspects of their occupation. Nonmedical factors include the patient's satisfaction with the job, economic motivation to work and perceived risk of continued work. Patients' perceptions of their capacity to work and the risks of such work are especially important determinants of occupational work status after myocardial infarction and coronary operations. Symptom-limited treadmill exercise testing carried out three to four weeks after the acute event not only clarifies prognosis and quantitates functional capacity but helps patients to realistically assess their capacity for work. Approximately half of postinfarction patients are found by such testing to have a very low first-year mortality of less than 2 percent. Functional capacity is well maintained in these patients: they do not require formal reconditioning in order to resume their occupational work soon (three to five weeks) after infarction. Exercise testing performed soon after myocardial infarction and coronary artery operation affords practical guidelines for clearing a person to return to work and obviates much of the medically unwarranted disability that follows these events.

Evaluating the capacity of a patient with coronary heart disease to carry out occupational work often poses a difficult problem for the physician. This is especially true after myocardial infarction or coronary artery operation. The reason for the difficulty is that many complex medical and nonmedical factors influence any recommendation regarding these patients' return to work. *Medical factors* include the physician's medical evaluation of the patient's prognosis and functional capacity and the patient's perception of the importance of cardiac symptoms and the risk of resuming occupational work. *Nonmedical factors* include the psychological status of patients, their level of job satisfaction and their perception of the influence of occupational work on their health, the family's influence on any decision regarding return to work, economic factors that influence a cardiac patient to continue working or to retire, the employer's decision to retain or to replace the patient and ill-defined legal and administrative considerations that often impede a cardiac patient's return to work.

Although the physician may influence the *medical* aspects of the return-to-work decision, *nonmedical* aspects over which the physician exerts little control, such as the patient's job satisfaction, often dominate the process. In addition, no randomized clinical trial has ever compared the risk of earlier versus later return to work after a myocardial infarction or a coronary artery operation.

Confronted with this formidable array of uncertainties and conflicts, it is no wonder that physicians often feel frustrated in their attempts to classify and enhance their patients' occupational work potential. Further,

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there are few guidelines for providing clearance for cardiac patients to participate in occupational work. As a result, physicians' advice is often vague and unnecessarily conservative concerning work. This may lead to potential errors in management:

1. Low-risk patients are unnecessarily restricted from engaging in occupational work, often with harmful psychological, physical and economic consequences.

2. High-risk patients do not receive optimal diagnostic evaluation and therapeutic intervention before returning to work, with potentially lethal consequences.

We present a pragmatic approach to the issue of occupational work evaluation which addresses three major determinants of occupational work potential in patients with coronary heart disease: prognosis, functional capacity and psychosocial status. Although these principles are particularly germane to patients recovering from myocardial infarction, they are also pertinent to patients with chronic stable angina pectoris and to patients recovering from coronary operations.

Prognosis

Of the three determinants of occupational work potential, *prognosis* is preeminent because job-related cardiac events naturally dominate the decision making of the physician, the patient, the patient's family and the employer. Unless all four of these parties have reasonable confidence that the risk of occupational work is low, none is likely to favor resumption or continuation of work. For this reason it is imperative that all parties be well educated concerning the risk of subsequent cardiac events and the capacity of the patient to tolerate the physical, environmental and psychological aspects of his or her job.

Clinical assessment of prognosis in coronary patients has traditionally relied on features of the hospital course, the history, the physical examination, the chest roentgenogram and the resting electrocardiogram. More recently various specialized techniques have been used to evaluate prognosis, including treadmill exercise testing, phonocardiography, echocardiography, ambulatory electrocardiography, radionuclide angiography, thallium myocardial perfusion imaging, right atrial pacing and coronary arteriography. The role of specialized evaluation techniques in assessing the prognosis of postinfarction patients is not well established; not only are the results of these various techniques redundant with one another, but they are often redundant with information provided by the clinical assessment. In fact, most patients who suffer subsequent cardiac events can be identified on clinical grounds alone.

The major determinants of prognosis after infarction are the extent of myocardial necrosis and thus the residual cardiac reserve and the extent and severity of persistent myocardial ischemia. Ventricular function changes little after the first week following infarction[1] and the incidence of exertional angina, ischemic ST segment depression and thallium perfusion defects remains relatively constant or declines only slightly in the first three months after infarction.[2] Thus, there appears to be little reason to defer the exercise test evaluation past the third week following infarction.

Postinfarction exercise testing

We have previously documented the independent prognostic contribution of treadmill exercise testing carried out soon after myocardial infarction.[3] The rationale for doing this evaluation soon after infarction is that such testing may identify patients with a high risk of subsequent cardiac events within the following eight weeks, thus permitting potentially effective therapeutic intervention during this period. Treadmill-induced exercise abnormalities during early testing are also predictive of late recurrence—that is, recurrence within the first five years after infarction.

We have developed a simple approach to stratifying the risk of subsequent cardiac events, such as sudden cardiac death and recurrent myocardial infarction (hard medical events) during the first six months following infarction. A combination of *historical* characteristics including previous infarction or angina pectoris (or both) or recurrent ischemic chest pain in the coronary care unit and *clinical* characteristics such as congestive heart failure and unstable angina pectoris permitted the identification of patients with a particularly high risk of cardiac events within the next six months. In these patients, who made up 10 percent of the sample of 702 men with a mean age of 54 ± 6 years, the rate of hard medical events was 18 percent. In patients with adverse clinical characteristics only, who comprised 30 percent of the population, the rate was 6 percent to 8 percent.

Of the remaining 60 percent of patients considered medically eligible to undergo exercise testing three weeks after infarction, 50 percent actually underwent such testing. Their rate of hard medical events within six months was 4.4 percent: 3.9 percent in patients with a negative test and 9.7 percent in patients with a positive test (ischemic ST segment depression of 0.2 mV or more and a peak heart rate of 135 beats per minute or less). Of the patients undergoing testing, 90 percent had negative tests by this criterion. Very low-risk patients with negative treadmill tests made up 46 percent of patients 70 years old or younger and 53 percent of patients 60 years of age or younger.[4]

Postinfarction exercise testing has an additional and complementary role in low-risk patients beyond the definition of prognosis: it is also useful in formulating individualized *guidelines for physical activity* in these patients. With the advent of automation, functional capacity has greatly declined in importance as a determinant of occupational work potential: the proportion of patients carrying out "heavy" work is no more than 5 percent to 10 percent. Further, persons who exert heavy physical efforts on the job are generally younger than those afflicted with myocardial infarction. Finally, low-risk patients as defined by negative treadmill exercise tests have a well-preserved functional capacity.[5] Even in patients who received no formal recommendations for physical reconditioning, the functional capacity seven weeks after infarction was 8.2

±1.9 MET (multiples of resting energy expenditure).* This level was adequate for the performance of all but the heaviest occupational tasks. The spontaneous increase in functional capacity from 7 MET at 3 weeks to 9 to 10 MET at 11 weeks reflects primarily an increase in peak heart rate and in arteriovenous oxygen difference and possibly in stroke volume. We and others have found no substantial improvement in ejection fraction measured by radionuclide angiography at rest or during exercise or in reversible perfusion abnormalities by thallium imaging during the first three months after infarction.[2] Thus it appears that the increase in functional capacity following myocardial infarction reflects primarily "peripheral" adaptations rather than "central" changes in pump function. In fact, much of the restoration of functional capacity that occurs in the first month after infarction may reflect a restoration of optimal intravascular volume following a period of bed rest and restricted physical activity.[6] Our later experience with exercise conditioning indicates that low-risk patients may safely augment their functional capacity through individualized low-level physical activity at home. Thus, even those low-risk patients whose occupations entail relatively vigorous effort may require little or no formal reconditioning before resuming their occupational tasks.

Functional Capacity

Blue collar workers generally return to work later after infarction than white collar workers. There is little medical basis for such distinctions among low-risk patients. In fact, it seems clear that these descriptive classifications of occupational work tasks should be replaced by a *functional* classification that incorporates assessment of prognosis and functional capacity. Recent experience has provided new insights into the process of occupational work classification of cardiac patients. This experience suggests that the potential for *myocardial ischemia* and *left ventricular dysfunction* developing during occupational work may be a more relevant performance criterion than *peak oxygen transport capacity*. Myocardial ischemia and left ventricular dysfunction are major determinants not only of prognosis but of functional capacity. The relevant question for the clinician to ask is how best to detect these abnormalities during the various combinations of physical, environmental and psychological stressors entailed in occupational work.

Past efforts in work classification have emphasized *laboratory simulation* of the patient's work environment, but this is cumbersome and difficult particularly as a way of assessing psychological stress. Rather than attempting to simulate the work environment in the laboratory, we have chosen to evaluate the *peak cardiovascular response* to various combinations of physical and environmental stressors.

*MET is a term derived from the word "metabolic," which describes the energy cost of various physical activities. One MET—the energy cost of quiet standing—is approximately equal to an oxygen consumption of 3.5 ml per kg per minute. The MET convention provides a convenient expression of the intensity of treadmill effort. This permits comparison of exercise performance on different exercise protocols.

Testing Arm Ergometry Versus Leg Ergometry

Symptom-limited treadmill exercise testing has been particularly helpful in these efforts. While large muscle dynamic effort such as treadmill testing and bicycle ergometry does not simulate many of the physical conditions involved in occupational work—especially static and dynamic effort involving the arms—these test methods are nonetheless effective as a basis on which to evaluate the patient's ability to perform occupational tasks of various kinds. Such symptom-limited dynamic testing elicits a clinically maximal cardiovascular response that is likely to expose clinically important myocardial ischemia and left ventricular dysfunction. In comparisons of symptom-limited leg ergometry and symptom-limited arm ergometry, the former was more effective in eliciting myocardial ischemia.[6] Arm ergometry rarely exposed ischemic abnormalities that were absent during leg ergometry; in contrast, leg ergometry exposed myocardial ischemia in some patients with negative arm tests. This is because cardiac output, heart rate and systolic blood pressure and thus myocardial oxygen consumption are higher during symptom-limited leg ergometry than during symptom-limited arm ergometry. For the same reason, we never noted ischemic abnormalities during the static effort involved in handgrip or forearm lifting carried out in the resting position; peak systolic blood pressure rose substantially, but the heart rate and cardiac output were only modestly increased and failed to elicit an imbalance between myocardial oxygen supply and demand. Even the combination of static effort and symptom-limited dynamic effort was no more effective than symptom-limited dynamic effort alone in eliciting a peak cardiovascular response and exercise-induced ischemic and arrhythmic abnormalities in coronary patients.[8]

Testing Dynamic Effort in the Cold

Other investigators have noted a similar phenomenon for dynamic effort in the cold: the ischemic threshold of heart rate and blood pressure at which exercise-induced ischemic ST segment depression and angina pectoris appeared, the peak heart rate and systolic pressure and the incidence of angina pectoris were similar when symptom-limited dynamic effort was performed in ambient temperature and in a cold environment.[9] We have noted the same for symptom-limited dynamic effort in the postprandial state.[10] The cardiovascular response to *symptom-limited* dynamic effort tends to override the effects of additional stressors such as the postprandial state, cold and the performance of static effort, each of which substantially increases the heart rate and blood pressure during *submaximal* dynamic effort. It thus appears that although the peak workload and the workload at the onset of ischemic abnormalities are diminished by cold, food ingestion and static effort, the peak heart rate and systolic blood pressure and the incidence of cardiovascular abnormalities at peak effort are similar to those observed during symptom-limited dynamic effort alone. Further, the heart rate appears to "track" the onset of ischemic abnormalities as effectively as the product of heart rate and systolic blood pressure.[10]

These findings considerably simplify the process of occupational work evaluation, for if ischemic abnormalities are absent during the symptom-limited dynamic effort of treadmill exercise or bicycle ergometry, they are also likely to be absent during most conditions encountered during occupational work. If such abnormalities are present during symptom-limited exercise, they tend to occur at a similar heart rate during repeated dynamic exercise testing and during circumstances in which cold, the postprandial state or static effort are superimposed upon dynamic effort.

Heart Rate

The heart rate and workload at which ischemic abnormalities appear during peak dynamic effort not only have prognostic significance but indicate whether these abnormalities are likely to appear during a patient's vocational activity. For example, exercise-induced angina pectoris appearing at a heart rate of 115 beats per minute is far more likely to interfere with a patient's activities than angina pectoris that appears at a heart rate of 145 beats per minute.

Heart rate is superior to tables of metabolic equivalents in regulating the intensity of occupational work in patients with coronary heart disease. Heart rate is an important determinant of peak cardiovascular response and hence of myocardial oxygen consumption and is therefore closely related to the onset of myocardial ischemia. Patients without exertional ischemic ST segment depression or angina pectoris therefore require no restriction of their physical activities, even within several weeks of myocardial infarction. In our experience it is distinctly unusual for a patient free of ischemic ST segment depression at three weeks to have clinically important ischemic ST segment depression of 0.2 mV or more during the next two months unless angina pectoris has appeared during this interval. On the other hand, patients with exertional ischemic ST segment depression or angina pectoris may not require restriction of their physical activity, especially if these abnormalities occur at a relatively *high* heart rate. If ischemic abnormalities occur at a relatively low heart rate, the more relevant concern is with prognosis, not with physical activity: such patients may benefit from further noninvasive or invasive diagnostic evaluation and from medical or surgical intervention.

Psychosocial Status

The third major determinant of occupational work potential is the patient's *psychosocial status*. This area is the most complex and most difficult to define in an individual patient. After myocardial infarction and, to a lesser extent, after coronary artery surgical procedures, patients and their families are often reluctant to allow resumption of occupational tasks for fear of precipitating myocardial infarction or death. Most patients and spouses perceive the heart as substantially weakened after myocardial infarction and prone to further damage by physical activity. Although these fears are usually medically unwarranted they may substantially limit a patient's occupational work potential.

Exercise testing is a useful technique for helping patients to form realistic expectations after infarction and coronary operations. The physical exertion of a symptom-limited exercise test carried out three to four weeks after an infarction or operation is usually the most strenuous physical effort the patient has undertaken since the acute event. Successful completion of this exercise test has a major immediate impact on patients' confidence in their capacity for physical activity. This confidence extends not only to the activities of rapid walking or bicycling, which are simulated by the exercise test, but to physical activities dissimilar to the test such as running, isometric effort and sexual activity. Patients' confidence increases further after a physician has explained the test results and provided specific guidelines for physical activity including resumption of occupational work.[11]

Postinfarction patients whose treadmill test findings are "negative" are reassured regarding their capacity to resume their customary physical activities. Patients with "positive" test results usually are reassured by learning that they may benefit from further diagnostic evaluation and from medical or surgical intervention. In either case, treadmill testing helps patients to form a realistic impression of their tolerance for the physical, environmental and psychological aspects of their usual activities. This may obviate much of the medically unwarranted disability that follows myocardial infarction and coronary surgical procedures.

Benefits of Early Return to Work

We have described the medical rationale for functional evaluation soon after a myocardial infarction or coronary artery operation and the interaction of prognosis, functional capacity and psychosocial status in determining a patient's occupational work potential. A major consequence of identifying low-risk patients is an earlier return to work for these patients—a consequence with major public policy implications. Although most patients ultimately return to work after heart attack, the duration of their convalescence is often excessive, at least in the low-risk subset. In our population as a whole, for example, the time at which patients return to full-time work is 81 ±40 days. If the return-to-work decision were made solely on the basis of prognosis and functional capacity, it appears that the delay in return to work of low-risk patients could be halved.

A shortening of convalescence of this magnitude would substantially diminish the costs of disability, which are a large proportion of all costs related to myocardial infarction. Of the 500,000 Americans who survive a myocardial infarction each year, approximately 250,000 are previously employed men of whom half would be medically eligible to undergo early treadmill testing. Shortening the return-to-work time from 81 to 53 days in these 125,000 patients would reduce disability costs from approximately $1.25 billion to $632 million a year, even when the unit cost of treadmill exercise testing of $160 is considered. The safety of early exercise testing and an earlier return to work of this magnitude in low-risk patients are implicit in this model. For a patient's employer, an earlier return to work means less disruption of work in progress resulting in lower costs for temporary help and less lost productivity. For insurers, it means lower costs for disability insurance payments to beneficiaries. For a patient, it means less loss of income. It is also likely that patients who return earlier to work on the basis of a negative exercise test will experience a lower rate of premature—that is, medically unwarranted—retirement with further economic benefits to employers and to patients.

Attractive as these economic benefits may be to employers, insurers and patients, they will not accrue unless patients and their families, employers and physicians are reassured concerning the safety of earlier return to work. Our emphasis on encouraging low-risk patients to return to work is therefore a pragmatic one: the occupational disability of such patients is largely *behavioral* inasmuch as it is medically unfounded and can be largely obviated by effective early evaluation and encouragement—an approach that is relatively inexpensive and therefore likely to be cost-effective. In contrast, the disability of high-risk patients is largely *medical;* it reflects important degrees of myocardial ischemia and left ventricular dysfunction—conditions that often require intensive (and expensive) medical and surgical treatment.

Future efforts to diminish occupational disability after a heart attack must therefore proceed along two parallel paths: (1) to demonstrate to patients and their families and to employers and physicians the safety of early return to work and (2) to actively enhance patients' perceived ability to tolerate the various stressors of their occupational work. This activist approach is in contradistinction to the passive approach—that is, allowing many weeks for the turmoil of myocardial infarction to dissipate and then often transferring patients to "less stressful" jobs. Although myocardial infarction is certainly a traumatic event, we have been impressed by the resiliency and adaptability of postinfarction patients who receive early functional evaluation and counseling.

These patients want to know what caused their heart attack and what they can do to prevent a recurrence. For example, many of our patients have cited job stress as an important contributor to the initial infarction. We have provided these patients with programs of stress management that are oriented to coping with occupational stress. Nearly half of our patients were smoking before their infarction and most perceived that smoking contributed to their heart attack. We have provided specific information on how to stop smoking and have continued to support patients' efforts to stop smoking. Patients have been advised how to manage occupational stress and to stop smoking in the context of individually tailored physical activity programs. Participation in daily physical activity affords an opportunity for patients to model healthy behavior. This appears to reinforce confidence in their ability to resume their customary activities, including their occupational work. In other words, this skills-oriented approach helps patients to modify their perceptions of their health. Patients who have received training in stress management, smoking cessation and physical activity conditioning appear more confident about their capacity to lead a normal life. These perceptions appear to have a major bearing on patients' willingness to resume or continue their occupational work. Whatever means are ultimately found most effective for enhancing patients' perceptions of their capabilities, this is an important objective of patient management—one which has major potential for enhancing the functional effectiveness of patients with coronary heart disease.

Low-Risk Versus High-Risk Patients

We have emphasized the identification and management of low-risk patients. How do we manage high-risk patients? Is their prognosis worsened by occupational work? Do therapeutic interventions enhance their occupational work potential? The principles of occupational work evaluation are similar in all patients: those at a high risk on the basis of adverse historical and clinical characteristics, especially the presence of congestive heart failure and unstable angina pectoris, should be considered for further diagnostic evaluation and therapeutic intervention. Using a stepwise risk stratification procedure, we correctly identified 72 percent of cases in which reinfarction or death occurred during the first year after infarction: of patients who were correctly classified, 35 percent had adverse historical characteristics (prior infarction or angina or recurrent chest pain in the coronary care unit, most of whom also had clinical heart failure or unstable angina pectoris), 55 percent had adverse clinical characteristics (clinical heart failure or unstable angina pectoris without adverse historical characteristics) and 10 percent had an abnormal exercise test finding in the absence of adverse historical or clinical characteristics.[4] Once the highest risk patients have been identified on the basis of historical and clinical characteristics, the prognostic value of specialized evaluation techniques, including coronary arteriography, is bound to be small.[12]

Early evaluation of prognosis facilitates early definitive therapeutic intervention in high-risk patients: if subsequent infarction and death are to be prevented in these patients, it is important that intervention be provided early. Levine and associates have shown the safety and benefit of coronary artery operations carried out within 30 days after infarction in patients with refractory angina pectoris.[13] The efficacy of coronary surgical treatment in improving prognosis has yet to be established in patients who are asymptomatic or mildly symptomatic after infarction.[14] At present we advocate coronary arteriography for patients with moderately severe angina pectoris and for patients whose three-week postinfarction test results are positive to a pronounced degree. We do not advocate coronary arteriography for patients with mild angina pectoris or for those with negative treadmill tests because their first year mortality is so low that they are not likely to benefit further from coronary artery operations. Using these criteria, it appears that fewer than a fourth of previously employed men 60 years old or younger would be candidates for coronary arteriography in the year after infarction.

Even if the prognosis of postinfarction patients can be defined with reasonable certainty, the influence of occupational work on prognosis is uncertain. The prognosis of patients who return to work is better than that of patients who do not—a reflection of more advanced disease in the latter.[14] There is a low rate of dropout from the working environment in patients who return to work after myocardial infarction: 4 percent to 6 percent within 12 months. There has been a presumption that a delay in return to work after infarction is in some way protective; that is, a return to work after three months is safer than an earlier return. Because the death rate is highest in the first three months after infarction, it is far more likely that the greater perceived safety of a three-month delay simply reflects the death of high-risk patients—deaths that could possibly have been prevented by earlier identification and therapeutic intervention. To determine whether early return to work influences subsequent outcome, a randomized clinical trial of medically comparable patients is necessary.

Cardiac symptoms do not represent an important limitation of occupational work potential: for example, many studies have documented a similar rate of employment in patients with and without angina pectoris. The widespread use of beta blockers and calcium antagonists is likely to further diminish the effect of symptoms on employment status. Even a coronary artery bypass graft operation, one of the most definitive types of treatments available for patients with coronary heart disease, does not appear to enhance employment status.[16] This is not because the surgical procedure fails to enhance functional status or to diminish symptoms, but because many other factors such as age, educational level and length of disability before the operation are even more important determinants of occupational work status. On the other hand, objective evaluation of cardiovascular status soon after a coronary artery surgical procedure and provision of explicit guidelines for physical activity, including return to work, are likely to augment the effectiveness of the operation in enhancing occupational work potential. This can be accomplished by exercise testing four to five weeks postoperatively. We have previously documented a large spontaneous increase in functional capacity after the procedure even in the absence of formal exercise conditioning.[17] These patients did not require formal conditioning in order to resume their customary occupational work.

Conclusions

The medical rationale for occupational work evaluation as presented here appears to have much potential for diminishing disability in low-risk patients after infarction but this potential has yet to be shown in a controlled clinical trial. Until such results are available, the principles of occupational work evaluation elaborated above will provide practical guidelines to physicians concerning work clearance for their patients with coronary heart disease.

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